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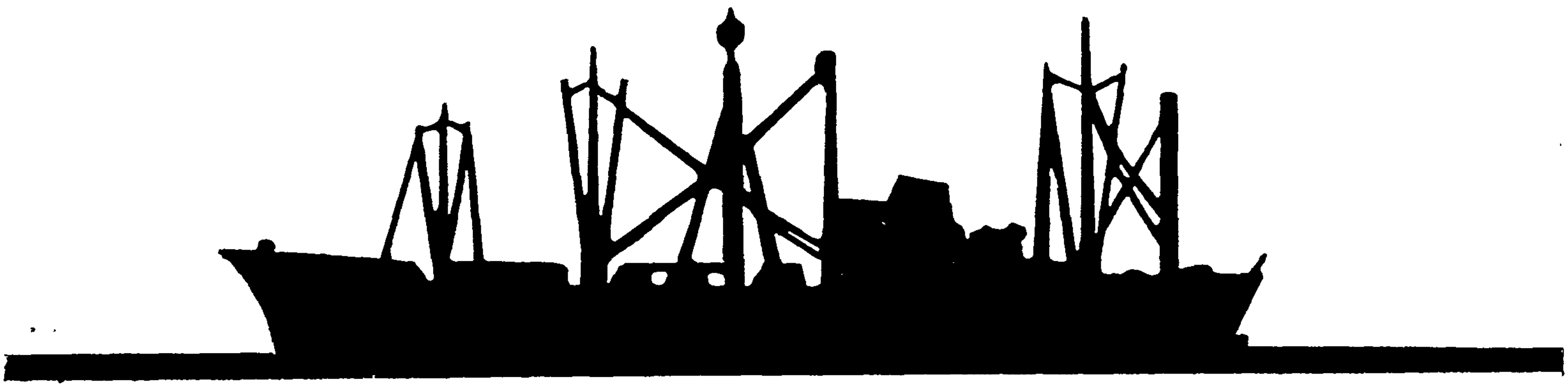


INSTITUTE FOR RESEARCH AND ENGINEERING FOR AUTOMATION AND PRODUCTIVITY IN SHIPBUILDING

I R E A P S

THE FUNCTIONAL APPROACH TO PROBLEM SOLVING IN THE SHIPYARD ENVIRONMENT

Owen Scott
Chief, Operations Engineering
Electric Boat Division
General Dynamics Incorporated
Groton, Connecticut

Mr. Scott has been with the Electric Boat Division of General Dynamics for the past 26 years. For the last 10 years he has been Chief of Engineering in the Operations Engineering Department. His functional responsibilities include an engineering support program to the shipyard (Operations Department) in two major areas: (1) A problem identification/resolution group, and (2) The Operations Departments Data Processing interface group. Since both groups are involved in all aspects of the shipyard and the shipyard organization, the day to day activities virtually span every aspect of the shipbuilding business. However, primary emphasis is directed at the manual and automated work control and information systems in direct support of the shipyard and the product.

Mr. Scott attended the University of Rhode Island. Prior to his current assignment, he held management positions in the Marine Engineering and Cost Engineering Departments.

Johan Collasius
Engineering Specialist
Electric Boat Division
General Dynamics Incorporated
Groton, Connecticut

Mr. Collasius has 10 years experience in the area of identifying problems, proposing solutions, and implementing solutions to manual and automated work control and information systems in direct support of the shipyard. His group has acted as the interface between system and end-users (shipyard trades) and the data systems service providing user definition for system data base requirements, output report design, detail logic design, and implementation plans.

Mr. Collasius has received a BS degree in industrial engineering from Southeastern Massachusetts University, a MBA degree with a concentration in operations research from the University of New Haven, and is currently enrolled in a Senior Professional Certificate program in computer science at the University of New Haven.

I. SYNOPSIS

This discussion will cover a structured problem solving methodology as it is used in the Operations Department at the Electric Boat Division of General Dynamics. A brief overview will describe several successful applications of the problem solving methodology. To provide an understanding of the concepts, a brief description of the technique used will be given.

II. GENERAL OVERVIEW

A. Introduction

One of the newest buzz words in Navy-related shipbuilding today is Tech Mod or Technology Modernization. This program is a self assessement of your current "as is" operation and the development of a proposed or "will be" operation. The methodology we are about to describe provides the capability needed to perform the analysis for documenting the "as is" and developing the "will be".

Information flow, material flow, and work-in-process flow are the life's blood of every company, organization, or department. Your ability to understand it, and analyze the problems that occur in it, has a significant impact on its efficient operation. In many companies, the process of determining what went wrong, and what to do to fix it, is an informal effort. In most cases, it is left up to operating management and consensus opinion. In larger companies, it may become a management team or industrial engineering responsibility. Regardless, eventually someone in the organization is held accountable for resolving "the problem".

In the problem solving business, the "problem solvers" have a varying life span (see Figure 1-1). And, as the illustration shows, if you are consistently good, it can be quite long and happy If not, you often stumble your way through, in which case, it is usually very short and sometimes even fatal.

I'm sure that all of you have, at one time or another, witnessed or have been involved in one of those problems that that has been around for some time. One that others, or even yourself, might have broken your picks on. If so, maybe you will recognize some of the jobs we have successfully tackled over the years (see Figure 1-2):

- Refuse Disposal System
  - Classified materials - drawings - hotel trash
  - Meeting all Federal EPA regulations

- Pipe "Target" System
  - Requirements definition
  - WIP Status and Control
  - Work closeout

- Division-Wide Inventory System
  - All WIP material
  - All material installed on submarines

- Inventory Reconciliation System including:
  - Procedures and training
  - Project management responsibilities

- Division Hazardous Waste Control System
  - Meeting all Federal EPA regulations

- Structural Steel Weld Accountability System

- Pilot Machine Shop Work Control System
  - Work breakdown (product structure)
  - Part numbering
  - Data base load
  - User procedures and training
  - Project management
  - Turn-key to production
  - Fleet immediate needs (short term)
  - Capable of evolving to an MRP system (long term)

- Numerous Trade Work Center Analysis

These are representative of the kinds of problems that could be encountered in any shipyard.

The point is that these problems were resolved and many others, using a very easily learned analysis technique. And, most importantly, we consistently do these types of jobs without falling into the usual pattern of solving the wrong problem right, one or more times, before finally stumbling onto the real problem and solution.

In fact, I tell my engineers that this is my biggest fear -- the fear of solving the wrong problem right. Let me give you one example because I think it illustrates what can, and often does, happen:

- Take the Refuse System previously mentioned - (see Figure 1-3):

  Back a few years ago, EB was having problems with their incinerator - it belched black smoke. It eventually got to the point where the EPA was threatening a $25,000 fine.

One of our sister engineering groups had already been tasked to solve the problem. In fact, they spent several months and nearly $100,000 trying to stop that incinerator from belching black smoke. Failing to do so; and after some further EPA stimulation, we were asked to go "take a look" at the "Incinerator Problem". Our approach was considerably different. We documented and analyzed the entire refuse disposal system at EB and eventually included our facility at Quonset Point, Rhode Island. Without going into all the details, our analysis included contract requirements, ASPER regulations, Nuclear Regulatory requirements, trash classification [how much of what kind from where]., facilities, and equipment. What we found was much more than an incinerator problem. Our solution was to, get rid of the incinerator and install a large scale sheer type shredder, coupled with an approved landfill operation. We wrote the specs for the shredder, monitored manufacturing of it, tested it, did the facility layout, obtained spec changes in our contracts, changed operating procedures, etc. And, that is how we dispose of trash today. And, there is no black smoke, no threatening EPA fine fines, and the refuse disposal system works just

I think that you can see that much more obvious solutions could have been developed:

- Perhaps eventually the incinerators could have been made to work, or maybe a more modern, higher temperature pressurized incinerator would have done the job -- maybe not.

Regardless, the point is that the final solution was not, and seldom is, the obvious! Actually, more often than not, the obvious is simply a sympton - seldom the cause. Permanent solutions are almost always the result of in-depth analysis.

III. OYERVIEW - ANALYSIS METHODOLOGY

A. Introduction

Essentially, the message we hope to impart here today is an understanding of the problem solving methodology or technique we use to consistently solve the right problem right! An easily learned technique whose basis is structured after a Honeywell education course called BISAD, modified to work for use in our environment, which can be modified and learned by you and applied equally as well in your environment. However, the intent of this presentation is not to taut Honeywell's technique, it is to illustrate that a structured, disciplined, functional analytical approach, will yield consistent successful results.

B. The BISAD (Business Information Systems Analysis and Design) Methodology

BISAD, as taught by Honeywell, covers two fundamental areas: (1) the Analysis Process; and (2) the process of Project Management. The discrete relationship between the two is that Project Management controls (manages) the implementation of the results of the analysis; in short, it gets the job done.

Briefly, described, the analysis methodology is a structured approach used to train computer systems people. When I say structured, I mean it is a defined step-by-step technique that proceeds from an interview phase called Background Analysis, to Functional Analysis, to Functional Design, to System Design, to the development of an implementation plan. A key element to the successful application of this methodology, is that it requires religious adherence to the technique - i.e., you do it by the book!

Project Management is tied directly to analysis because the ultimate success of the analysis can only be realized if and when full implementation takes place. Most importantly, it gives the project manager the "tool" he needs to control and status implementation.

C. Methodology Overview

Conceptually, the BISAD Analysis and Project Control technique is illustrated as shown here (Figure 2-1). The purpose of this overview being to familiarize you with each phase of the analysis, and the terms used. What is illustrated here is that as a result of the background analysis interviews, several analytical steps are taken. First, a Function Activity Chart is developed. This is the identification of the activities performed and a grouping of the common or similar activities into what is called a function. For example, an Inventory Control function might consist of a grouping of activities called: scheduling, planning, inventory adjustments, purchasing.

The Function Activity Chart is then further developed in the form of a Total Information Interface Diagram whose acronym is called a "TIID". This diagram identifies the generic information that must flow between each function (inputs and outputs) in order for it to exist. For example, one input into the Inventory Control function might be material requirements from the Production Control Department; while the output would be the release of a purchase order. So, in reality, you have created a defined, illustrated picture of the problem, the generic information, and how it flows, including its interfaces.

This phase is followed by a further breakdown of the information identified in both the Function Activity Chart and the Total Information Interface Diagram (TIID). The analysis now takes the form of a Functional Information Interface Diagram or (FIID).. As shown by the illustration, a FIID is an illustrated breakdown of each function. It identifies the information flow (inputs and outputs) in terms of the documents themselves. For example, in the case of the Inventory Control function, you might find the purchase order is now called a Delivery Request, and so on. FIID's are developed for each function, thereby, defining in detail the information flow in and out of each function as it exists.

The Detail System Design phase is essentially a combining of the FIID's into one defined illustrated diagram that reflects the total proposed system, incorporating all. changes made to the existing system.

Lastly, all of the activities required to achieve implementation are identified and then sequenced in a modified PERT type diagram. This then becomes the Project Manager's control and status mechanism in the form of an implementation plan.

Remember these basic steps of (Figure 2-2):

- Background Analysis
- Function Activity Chart
- Total Information Interface Diagram (TIID),
- Functional Information Interface Diagram (FIID)
- Detail System Design
- Project Implementation Plan

IV. PIPE HANGER PROBLEM ANALYSIS MQDIFIED; BISAD; METHODOLOGY

The following will illustrate how the modified version was used to solve an actual problem at Electric Boat Division: identifying and controlling piping hangers to support both the installation and tests of piping systems.

A few months ago, Pipe Shop Management requested that a system be developed for identifying the availability and controlling installation of piping hangers. The first step was to document the way they were currently operating and to identify the operating problems. This step is a more structured flowcharting requirement than the background analysis approach in BISAD. As part of the background analysis interviews with operating management, we developed a Function/Activity Chart depicting the existing method of operating You can see, it lists the functions required by the

the system down the left-hand side and the activities across horizontally. For example, the Central Trade Planning function consists of four activities: work scope definition, installation planning, design change evaluation, and closeout evaluation.

The next step was to take the information that was gathered and the Function/Activity Chart and develop an existing system - Total Information Interface Diagram or TIID (Figure 3-Z). Each of the functions identified in the Function/Activity Chart became a box on the TIID and each line between the boxes showed a type of information flow. This provided us with an overview of how all of the functions involved with piping hangers interacted with each other.

The next step was to take each of the functions on the TIID and Function/Activity Chart and develop a Functional Information Interface Diagram or FIID for it (Figure 3-3). Each of the activities identified on the Function/Activity Chart becomes a processing block on the FIID and the lines and documents flowing between activities provide a graphic illustration of what goes on within each function. For example, there were four activities on the Function/Activity Chart for the Central Trade Planning function and there are four blocks on the Central Trade Planning FIID. It identifies the documents used to transfer information from activity to activity and shows the interfaces that each activity has with other functions (those that are shown in dotted lines). These are the tools that we used to analyze the information flow, activities, and computer files to identify operating problems, additional information requirements, and redundant activities.

While performing the documentation, developing the TIID, and the FIID's, we add another enhancement to the BISAD technique - the Formal Problem Log - (Figure 3-4). The problem log is utilized in each phase of the analysis of the existing system and during design and implementation of the proposed system - (Figure 3-5).

We start maintaining the log during our initial interviews with Operating Management and religiously maintain it throughout the study. This gives us the problem baseline which our proposals must resolve. If all problems are not resolved to everyone's satisfaction, then it is back to the drawing board.. The problem log is also a valuable tool to aid us in developing both short-term and long-term solutions to problems. As you all know, many times there simply is not enough time to develop and install the final solution, and an interim or short-term step that dovetails with the long-term solution is implemented.

In short, if you want to be consistently (and I underscore consistently) effective, you have to have a reliable technique to identify the real problems and then, where needed, be able to develop short, as well as long-term solutions. The problem log along with our modified BISAD functional analysis technique are the tools we have used to accomplish this for the past 8 years.

What we found in the hanger system were several operating problems which were impacting our ability to correctly identify installation requirements, availability, and status of those requirements in relation to a specific test schedule. Once we had the problems isolated, our proposal included the solutions which were designed and presented in the same format - TIID's and FIID's (Figure 3-6) where the changes were highlighted.

The proposed hanger system included development and load of pipe hanger installation requirements to a data base. These requirements were in turn identified to test sections and statused for material availability and installation completeness. Using the computer data base, we then sorted the requirements file and obtained the information in any format needed.

A further enhancement will be to identify and load the area of the ship that the hanger is located in, so that we will be able to obtain requirements and installation status by area of the ship as well.

Once approved for implementation, the FIID's formed the basis for the detail level flowcharts (Figure 3-7) which, when literally translated, became the department operating procedures. The detail level flowchart shows "how" the proposed system works. It shows what decisions have to be made and the actions that take place to make the system work.

The next step was implementation of the new system. To control the implementation, we utilized the Project Control Methodology. We identified the individual activities with dependencies, estimated the span times, assigned responsibilities, and determined resources required. These activities were then drawn into a simplified PERT type chart (Figure 3-8) implementation plan. This implementation plan then became our control mechanism (on one piece of paper) identifying the specific activities that were required, the sequence they had to take place in, the schedule and identified who was responsible for accomplishing the activity.

As each implementation activity is completed, the appropriate "bubble" is colored in so that we can see, at a glance, the status of implementation (Figure 3-9). The implementation chart also highlights those individuals on schedule and more importantly, specifically who is holding up implementation. Likewise, it identifies to the project manager where he has to allocate more resources and do the pushing to get implementation back on track and keep it there! It sounds simplistic because it is - and most importantly, it works!.

That was a brief overview of how a modified version of BISAD is applied at the Electric Boat Division. I might note that all of the engineers in our group have had the formal BISAD training taught by Honeywell. As you can see, the technique can be learned and applied by anyone, to identify and solve problems in essentially any type of business environment including shipyards.

V. <u>SUMMARY</u>

The summary is short and to the point! (Figure 4-1) The modified BISAD systems analysis methodology is the analysis methodology used. In short, it includes a formal documentation of the existing system in the form of a <u>Function Activity Chart</u>, a <u>Total Information Diagram (TIID)</u>, and then in a lower level of detail, a <u>Function Information Diagram (FIID)</u>. Throughout each step, a formal problem log is developed and maintained. The solution or proposal is then simply a re-drawing of the Functional Information Diagram to incorporate the change necessary to solve the problems. This then becomes the Detail System Design. The translation of these documents into words becomes the operating procedure. They also serve as the training guides.

Every analysis includes a proposed project implementation plan with defined, sequenced activities, assigned responsibilities, the resources, and scheduled spantime to accomplish it. The only other key ingredient is a religious adherence to the methodology. Everyone uses it; and everyone uses it the same way - by the book!

Simply stated, it is an easy-to-learn, effective, <u>standard means</u> for doing problem analysis, systems analysis, and system design, while the project management plan ensures that the job gets implemented.

FIGURE 1-1

PROBLEM SOLVERS' LIFE SPAN ?

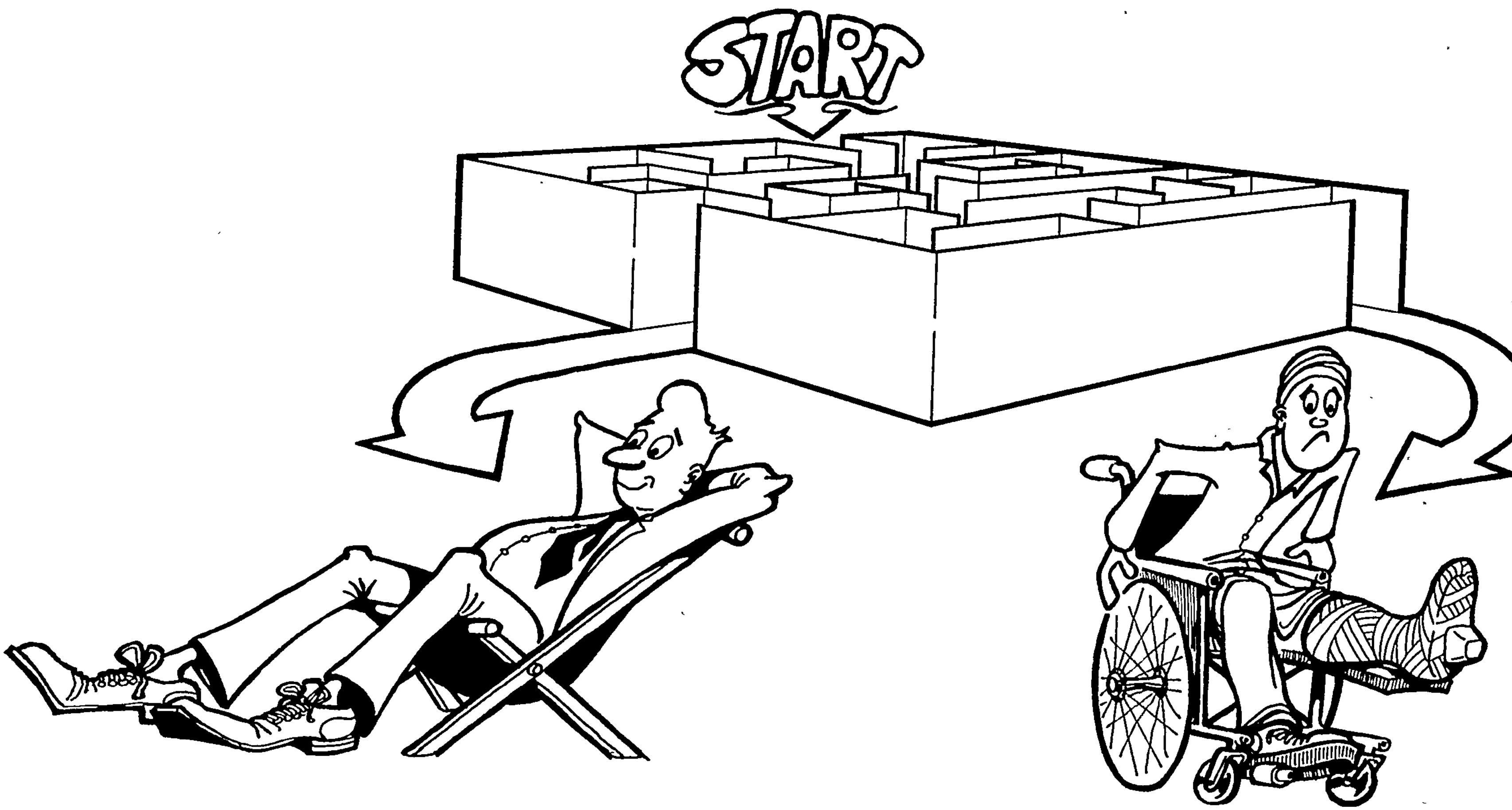


FIGURE 1-2

SAMPLE PROBLEM LIST

- REFUSE DISPOSAL SYSTEM
- PIPE SYSTEM FINAL CLOSURE “TARGET”
- DIVISION-WIDE INVENTORY SYSTEM
- INVENTORY RECONCILIATION SYSTEM
- HAZARDOUS WASTE CONTROL SYSTEM
- STRUCTURAL STEEL WELD ACCOUNTABILITY SYSTEM
- PILOT MACHINE SHOP WORK CONTROL SYSTEM
- TRADE WORK CENTER ANALYSES

FIGURE I-3

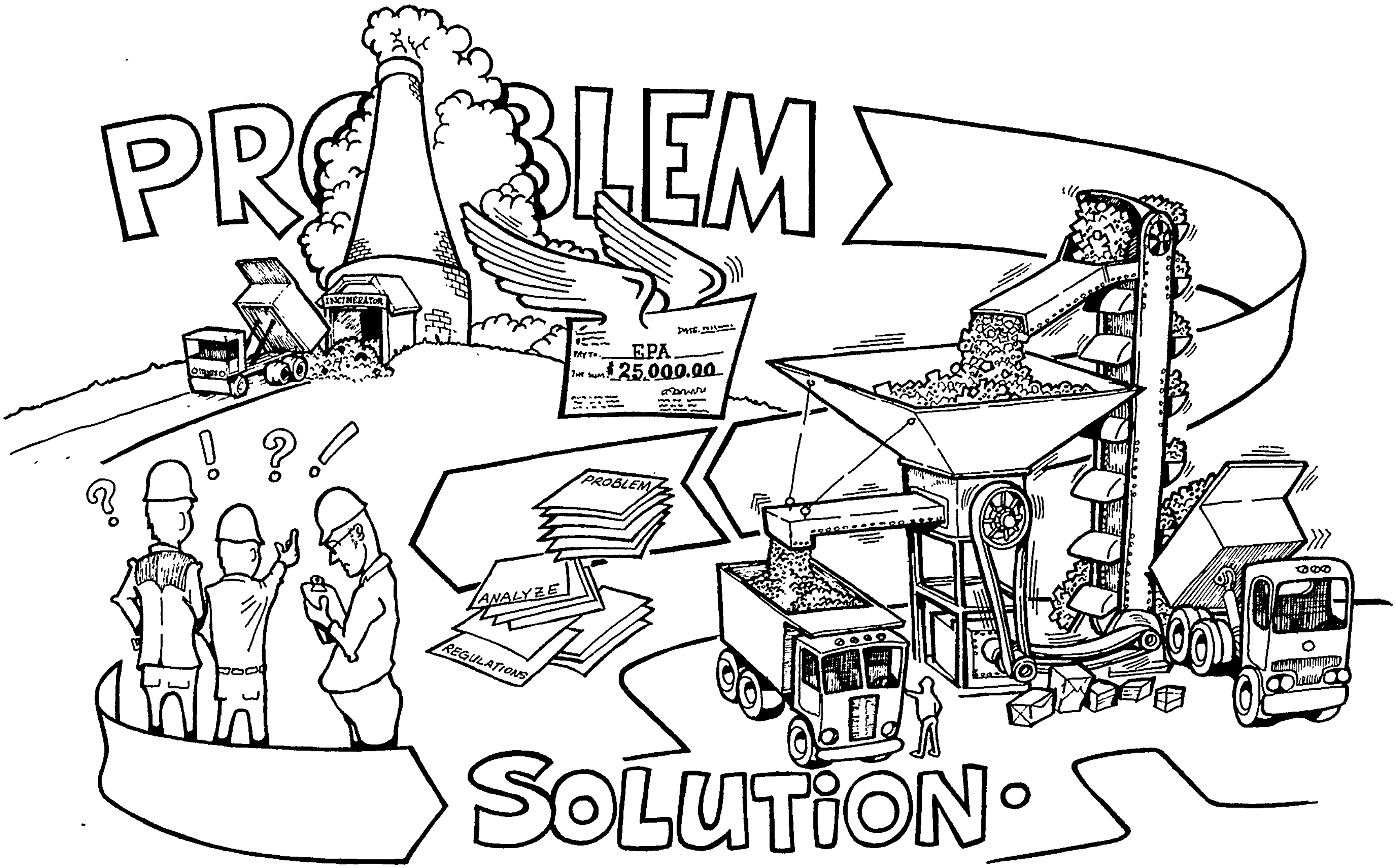
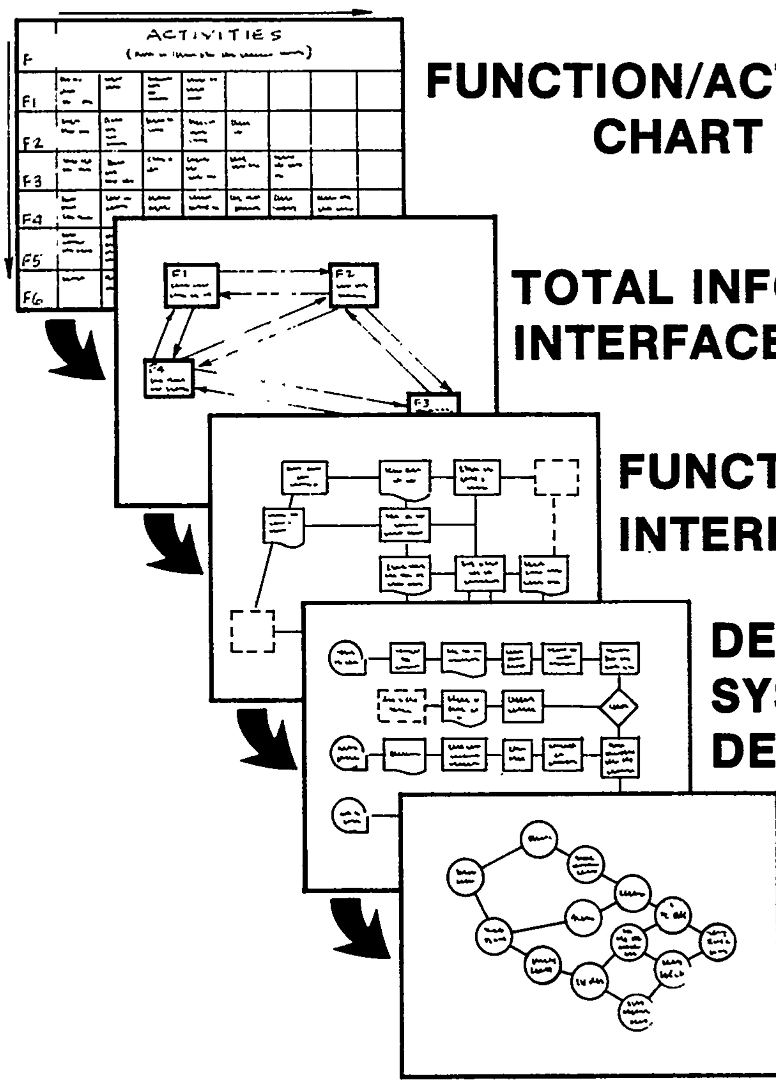

PROBLEM
INCINERATOR
DATE
PAY TO
EPA
$25,000.00
PROBLEM
ANALYZE
REGULATIONS
SOLUTION

FIGURE 2-1

BISAD CONCEPTS



FUNCTION/ACTIVITY CHART

TOTAL INFORMATION INTERFACE DIAGRAM

FUNCTIONAL INFORMATION INTERFACE DIAGRAM

DETAIL SYSTEM DESIGN

IMPLEMENTATION PLAN

FIGURE2-2

BISAD ANALYSIS STEPS

- BACKGROUND ANALYSIS
  - FUNCTION ACTIVITY CHART
  - TOTAL INFORMATION INTERFACE DIAGRAM - TIID
  - FUNCTIONAL INFORMATION INTERFACE DIAGRAM - FIID
- DETAIL SYSTEM DESIGN
- PROJECT IMPLEMENTATION PLAN

FIGURE 3-1

HANGER SYSTEM FUNCTION/ACTIVITY CHART - EXISTING SYSTEM

FUNCTIONS	ACTIVITIES					
INVENTORY CONTROL	PRODUCTION SCHEDULING	PRODUCTION PLANNING	INVENTORY CONTROLS ADJUSTMENT	INVENTORY ADJUSTMENT	PURCHASING	
MANUFACTURING (AVENEL)	MFG. PLANNING	MANUFACTURE	SHIPPING			
MIDWAY WAREHOUSE	RECEIVING	STOCKING	PICKING	STAGING	SHIPPING	PHYSICAL INVENTORY
CENTRAL TRADE PLANNING	WORK SCOPE DEFINITION	INSTALLATION PLANNING	DESIGN CHANGE EVALUATION	CLOSEOUT EVALUATION		
SATELLITE PLANNING	MATERIAL ORDERING	MATERIAL RECEIVING	INSTALLATION PLANNING	CLOSEOUT INITIATION		

FIGURE 3-2

TOTAL INFORMATION INTERFACE DIAGRAM (TIID)

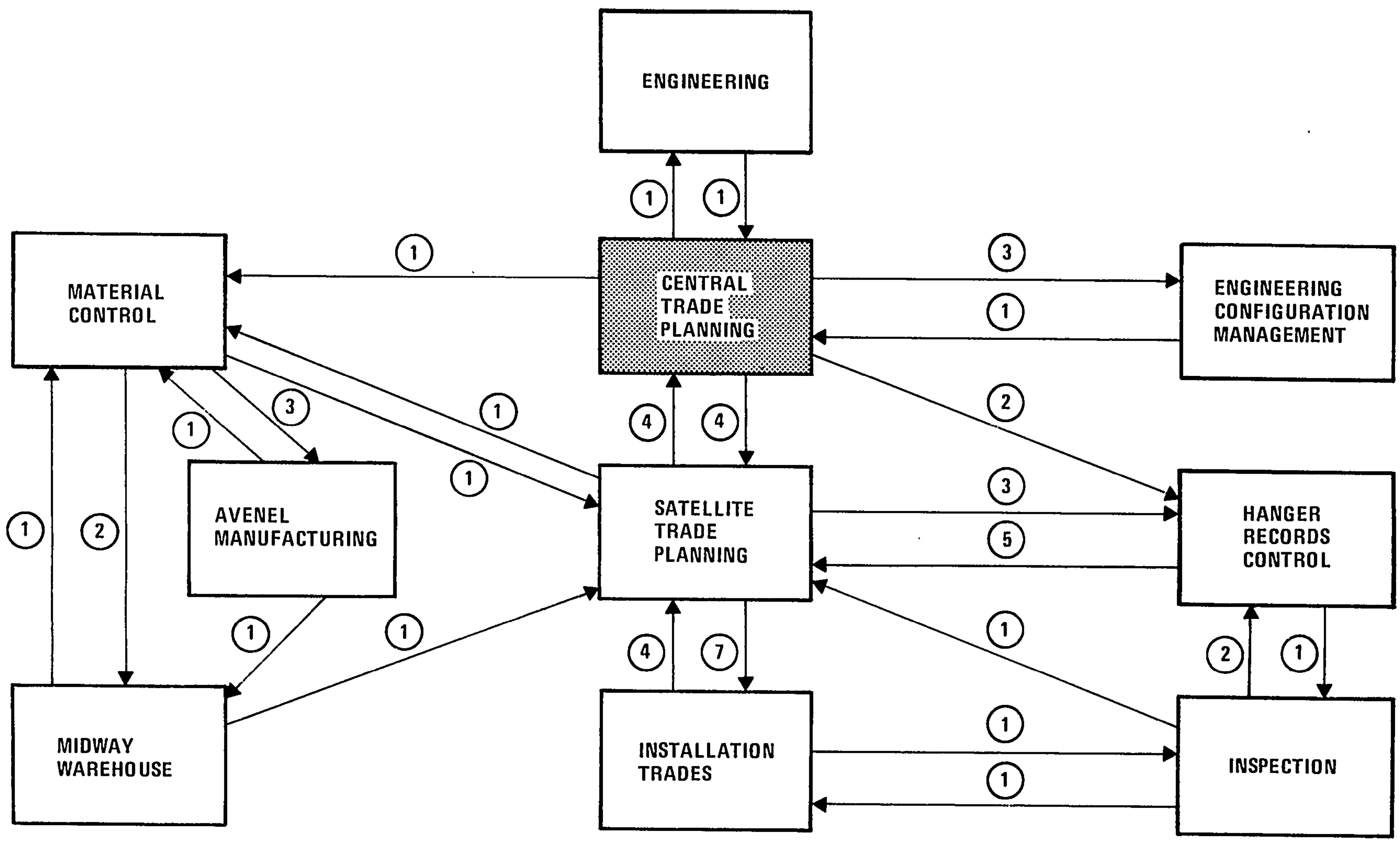


FIGURE 3-3

FUNCTIONAL ANALYSIS – FIID

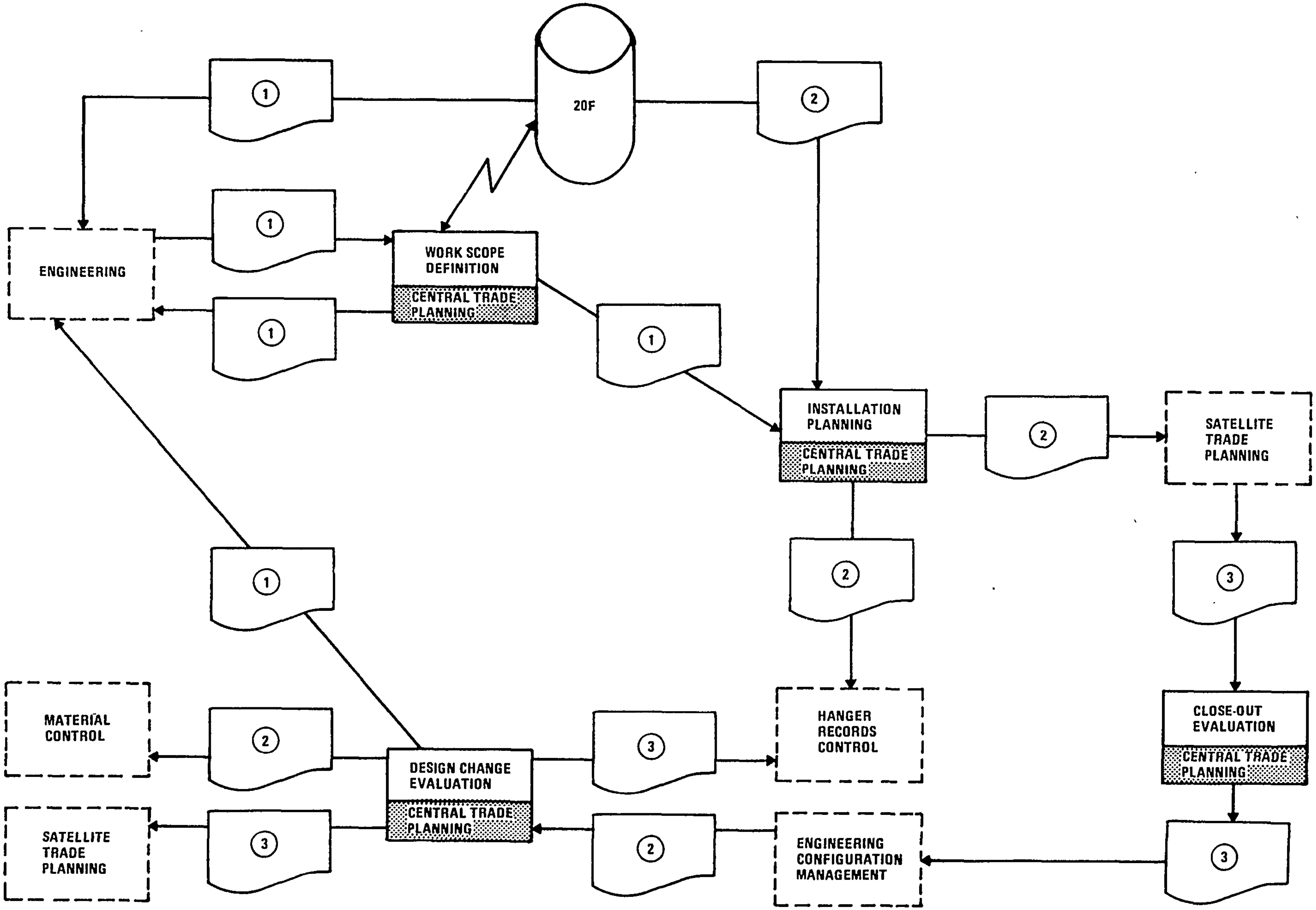


FIGURE 3-4

PROBLEM LOG

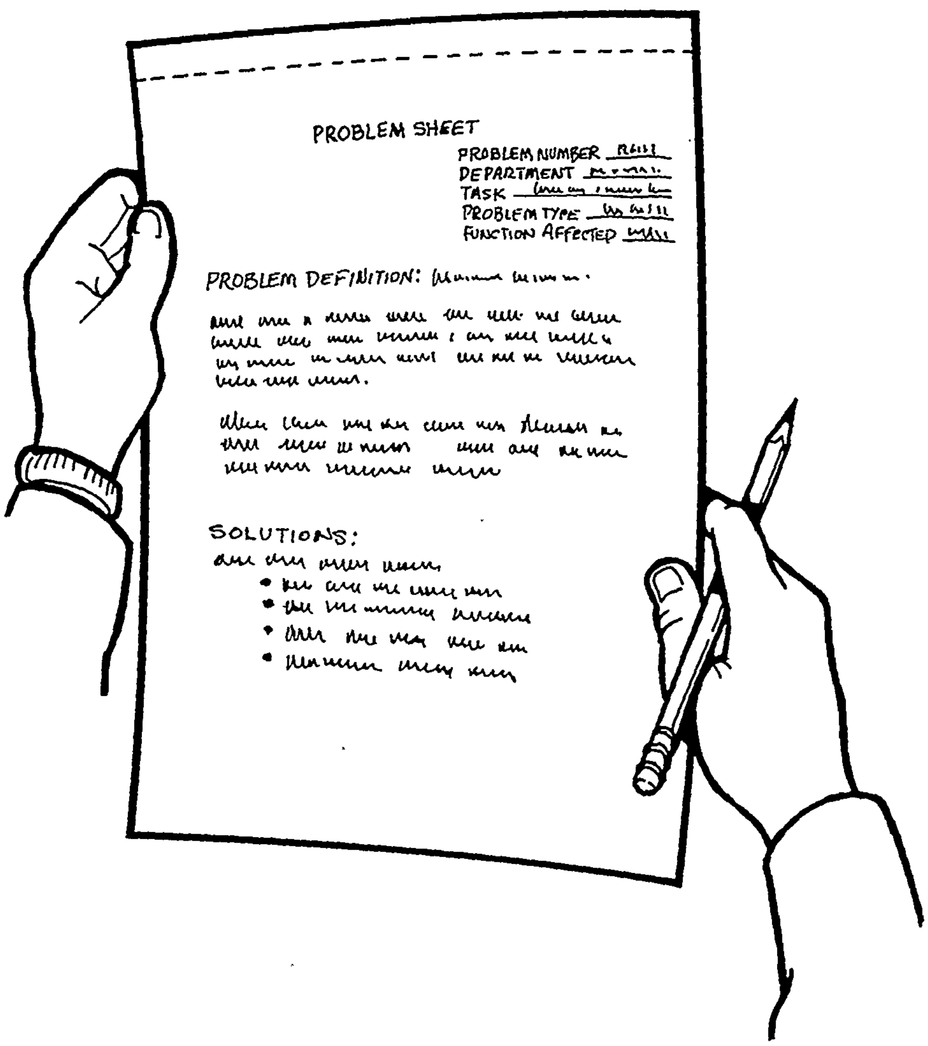


FIGURE 3-5

BISAD CONCEPTS WITH MODIFICATION

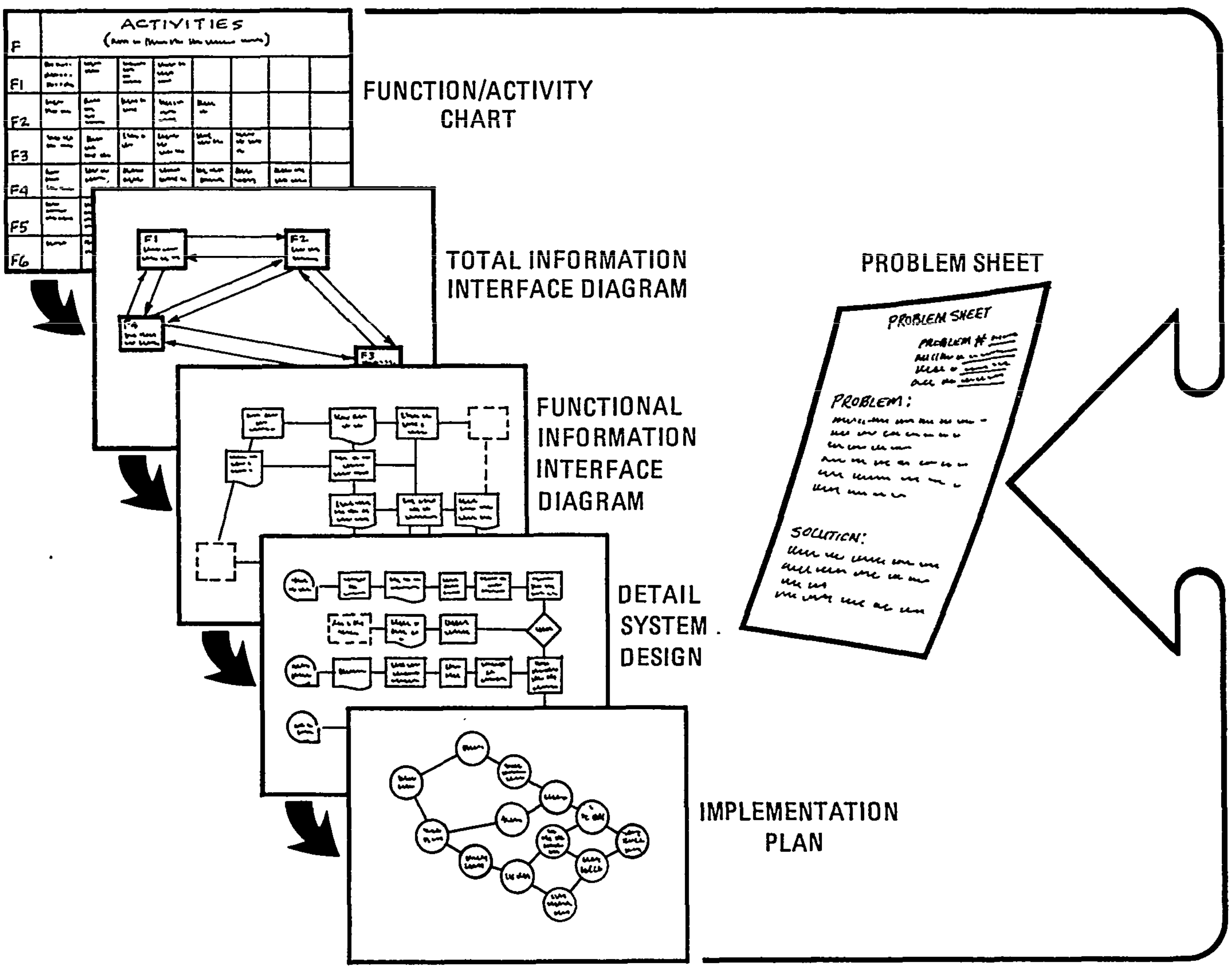


FIGURE 3-6

SYSTEM PROTOTYPE - FIID

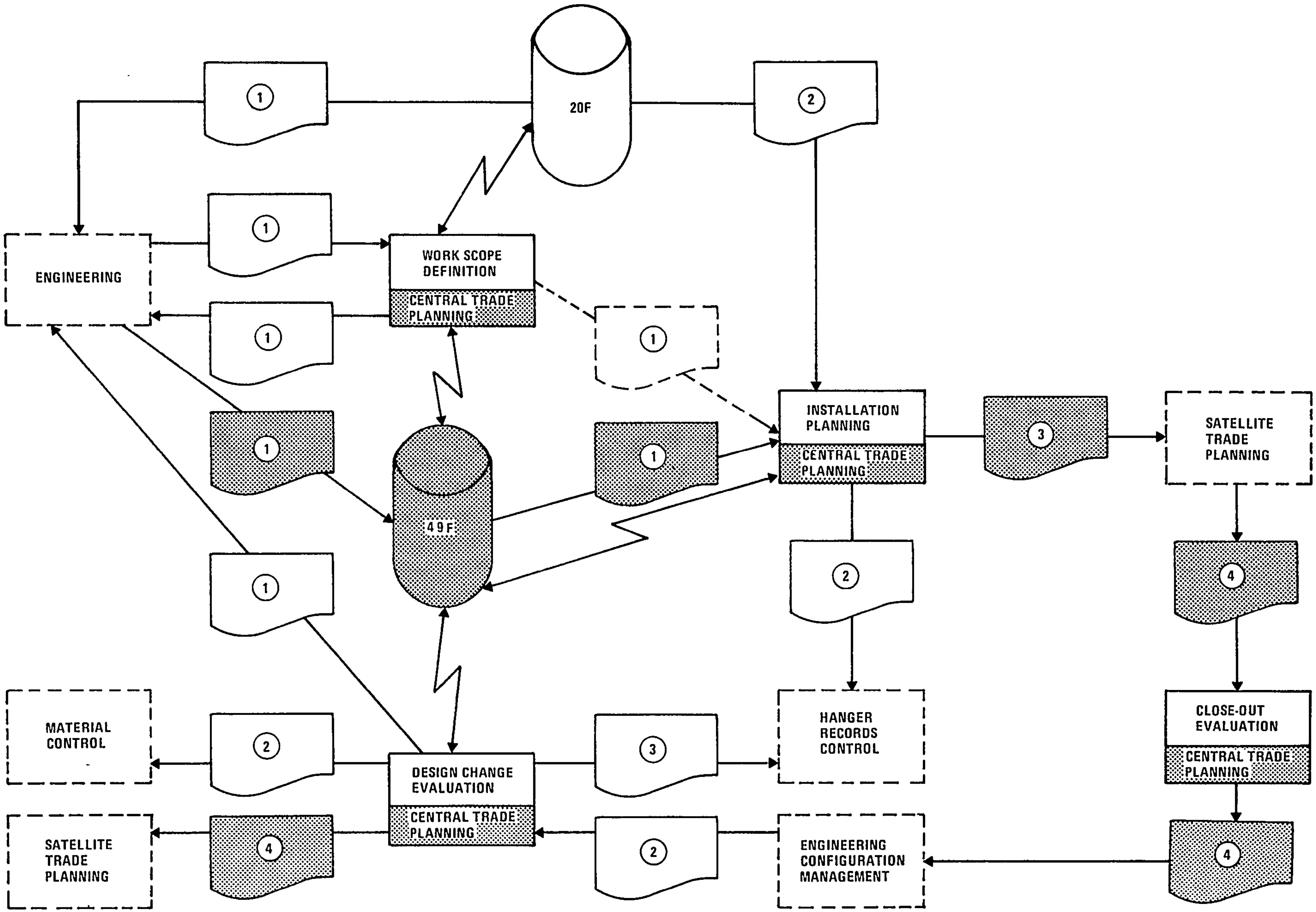


FIGURE 3-7

WORKING SYSTEM DESIGN

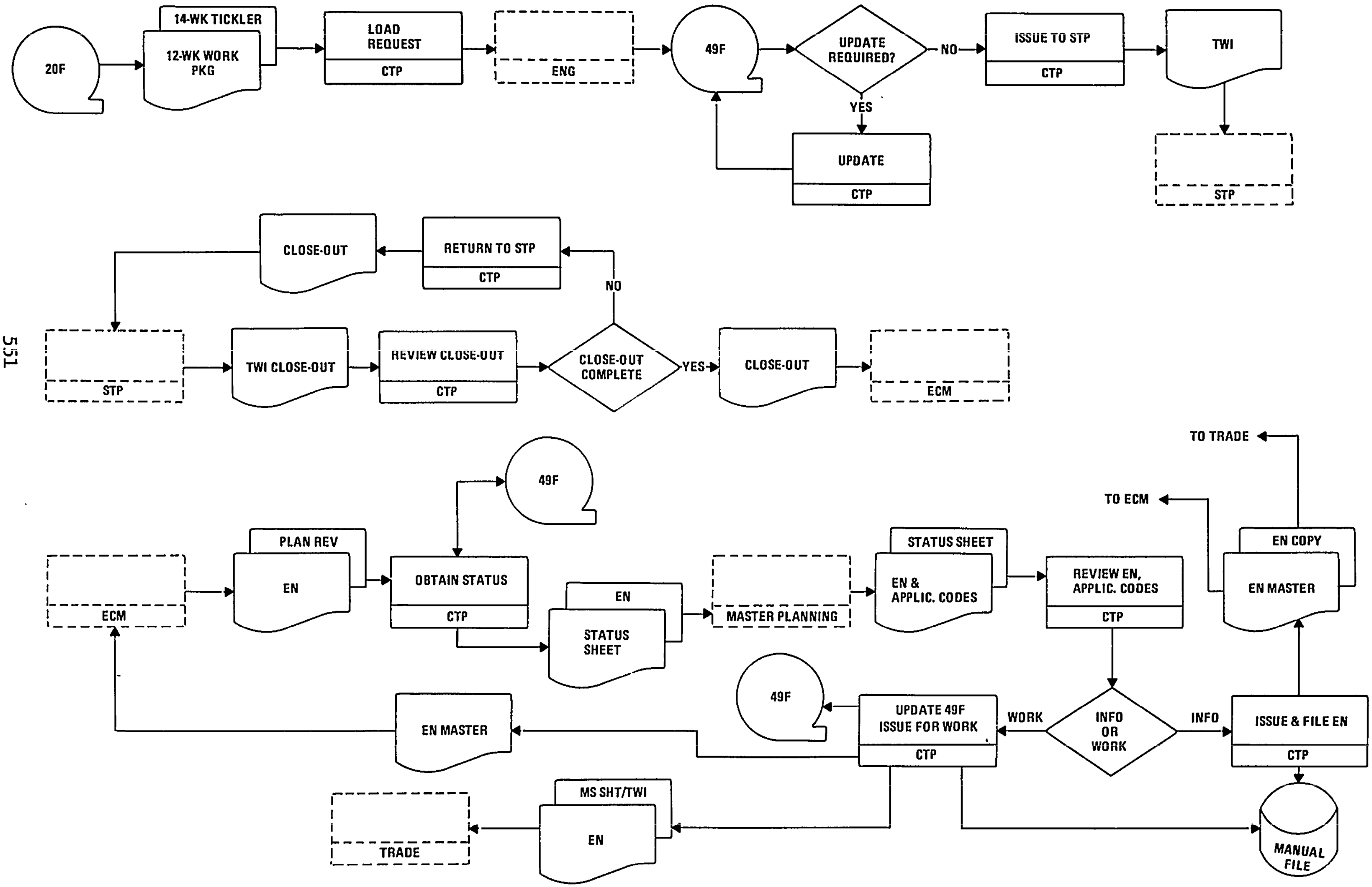


FIGURE 3-8

IMPLEMENTATION PLAN

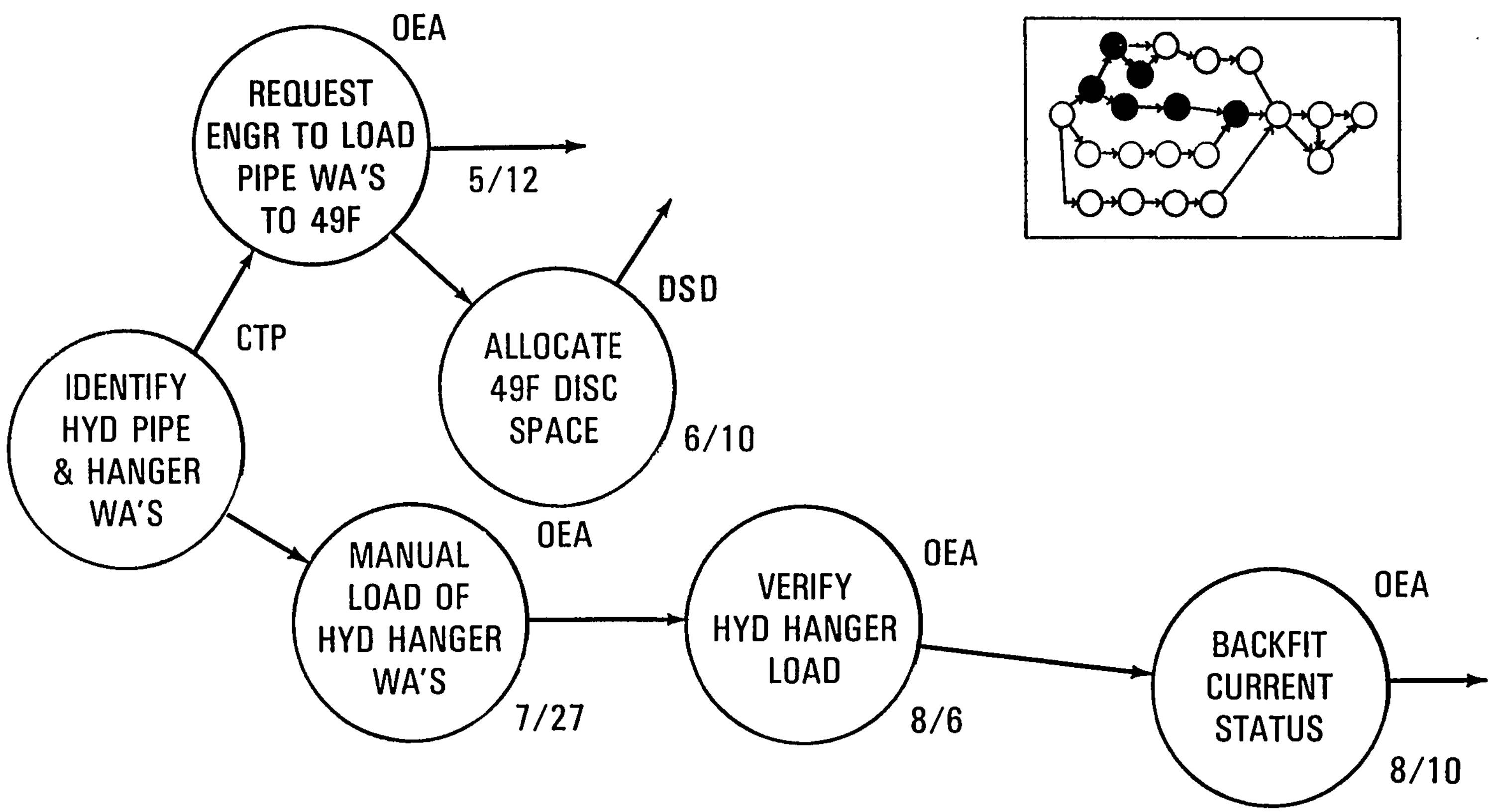


FIGURE 3-9

STATUSED OPERATIONAL IMPLEMENTATION PLAN

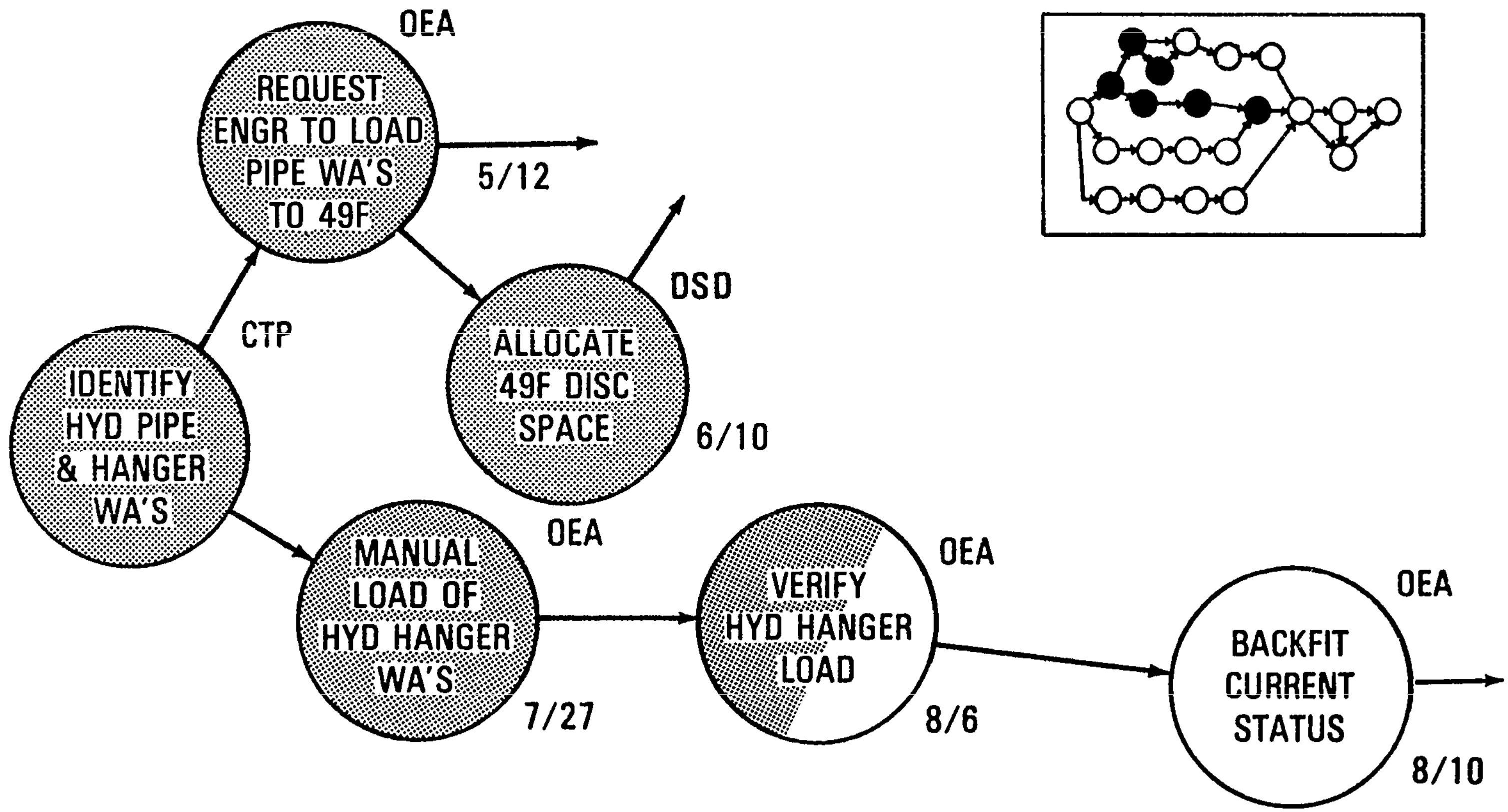
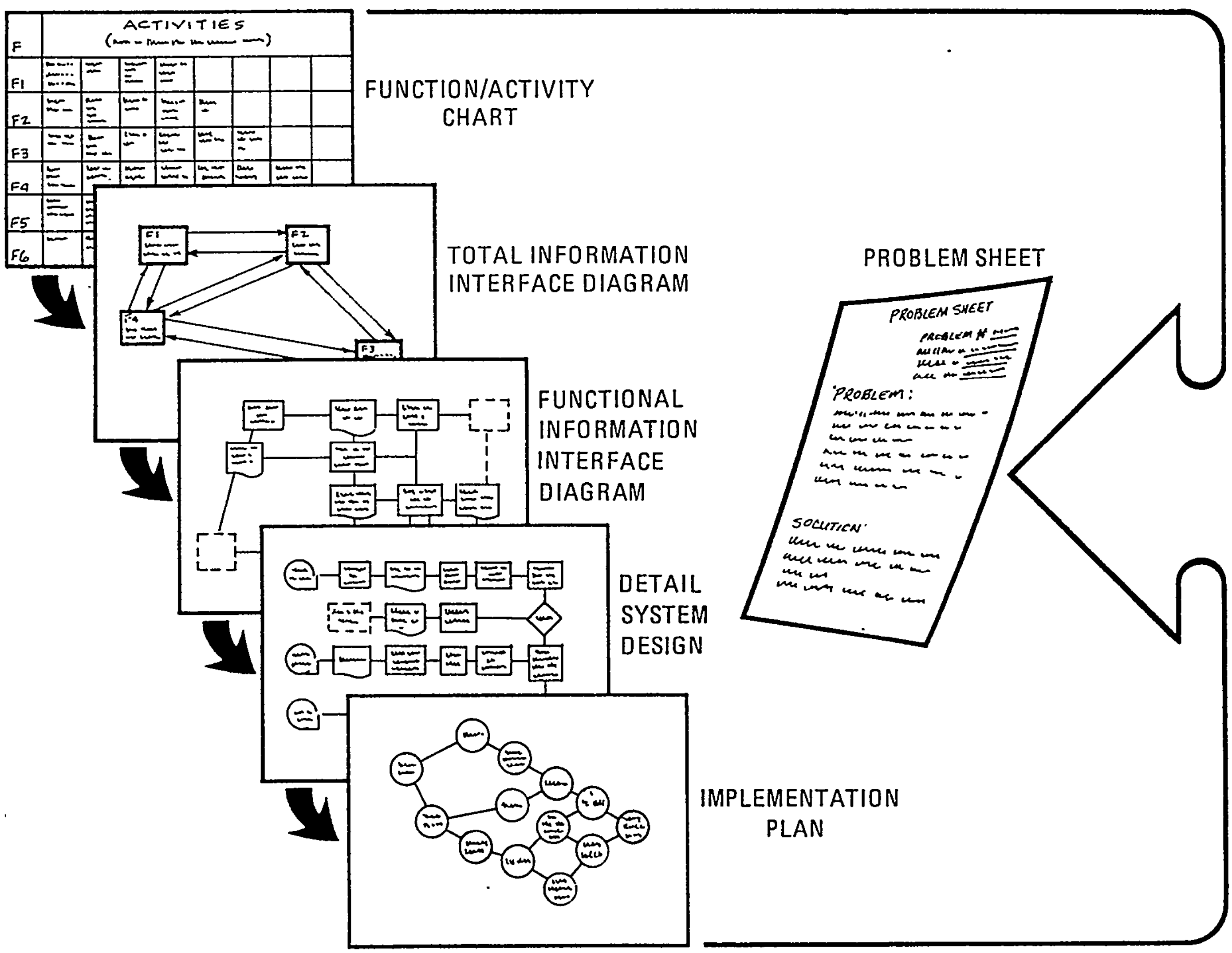


FIGURE 4-l

PROBLEM SOLVING OVERVIEW



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